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Cross-Country Evidence on the Impact of Shifting Economic and Strategic Landscapes on the Global Defense Industrial Base

4 November 2010

by

Dr. Nayantara Hensel, Chief Economist

Department of the Navy

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Abstract

Over the past twenty years, following the end of the Cold War, the defense industrial base in the US has witnessed many changes and continues to face new challenges. The purpose of this study is to evaluate the evolution of the US and global defense industrial base in response to the shifting economic and strategic landscape. Specifically, it examines the impact of macroeconomic factors on the defense industrial bases in the US and overseas, and discusses the trends in fiscal debts and deficits and their potential impact on military spending. Second, it discusses the impact of the shift in defense priorities toward irregular warfare and away from conventional warfare on the defense industrial base, and discusses areas of growth, as well as potential shrinkage. Third, it evaluates the ability of large defense contractors to compete with smaller firms in growing market spaces due to rising legacy overhead costs, as well as the financial impact of the strategic business base shift of large defense contractors. The analysis then assesses the development of the global defense industrial base and the role of foreign contractors in the US defense industrial base. In examining global supply chain arrangements, which promote interlinkages between domestic industrial bases, the study looks at the role of exchange rate volatility and declining military spending on defense products. Finally, the analysis examines the greater overseas orientation of elements of the US defense industrial base which are focused on traditional military equipment, as well as the growth of overseas defense industrial bases.

Keywords: US and global defense industrial base, shifting economic and strategic landscape, defense contractors, foreign contractors, global supply chain arrangements, exchange rate volatility and declining military spending.

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About the Author

Dr. Nayantara Hensel is the Chief Economist for the Department of the Navy. She provides economic guidance on growth projections, the federal budget, interest rates, unemployment, exchange rates, inflation, the financial health of defense contractors, as well as trends in the broader economy and in the defense sector. Dr. Hensel received her BA, MA, and Ph,D. from Harvard University, where she graduated magna cum laude and Phi Beta Kappa and specialized in finance and economics. She has taught at the US Naval Postgraduate School's Graduate School of Business and Public Policy, Harvard University, and the Stern School of Business at New York University (NYU). In the private sector, Dr. Hensel previously served as Senior Manager and Chief Economist for Ernst & Young's litigation advisory group, as managing economist for the New York City office of the Law and Economics Consulting Group (LECG), and an economist in the economic consulting arm of Marsh & McLennan. Dr. Hensel has written over 30 articles and research reports. Her recent research has focused on globalization and the US defense industrial base (the USAF tanker competition), the role of defense mergers in improving weapons systems cost efficiency, efficiency in IPO auctions relative to traditional processes, the factors impacting discount rates for US Marine Corps personnel, and market structure-specific and firm-specific factors impacting economies of scale and density in European and Japanese banks. She has published in the *International Journal of Managerial Finance*, *the Review of Financial Economics*, *Business Economics*, *the European Financial Management Journal*, *the Journal of Financial Transformation*, and *Harvard Business School Working Knowledge*. She is on the board of the National Association of Business Economists (NABE) and is one of 34 elected members to NBEIC, which is a group composed of the top corporate economists in the US. Dr. Hensel has given seminars at a number of institutions and has appeared on CNBC, Bloomberg Radio, and CNNMoney.

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I. Introduction

Over the past twenty years, following the end of the Cold War, the defense industrial base in the US has witnessed many changes. First, reductions in defense budgets during the 1990's contributed to consolidation among US defense contractors and a contraction in the US defense industrial base. Many defense industry sub-sectors manifested a 2/3 reduction in the number of prime contractors and came to be dominated by larger defense giants formed from the consolidations: Lockheed Martin, Boeing, Northrop Grumman, Raytheon, and General Dynamics. Second, the post 9/11 period has witnessed an increased emphasis on insurgent forces as the immediate threat to developed countries, rather than modern nation-states with similarly technologically advanced military equipment, thus leading to an evolution toward insurgent warfare and away from conventional warfare, which has contributed to areas of growth and areas of decline in the industrial base. Third, with the onslaught of the global financial crisis in 2008, the trajectories of expansion in the global defense industrial base are shifting downward as the need for economic austerity and budget deficit / debt reduction puts greater pressure on various areas of the budget, including military spending. As a result, the challenges for large US defense contractors are growing, as they compete with smaller entrants in certain product areas, as they struggle to evolve their business base towards growing markets and growing product segments, and as they handle the dual role of foreign countries and foreign defense contractors as allies and customers on the one hand, and as competitors on the other hand.

The purpose of this study is to evaluate the evolution of the US and global defense industrial base in response to the shifting economic and strategic landscape. Specifically, it examines the impact of macroeconomic factors on the defense industrial bases in the US and overseas, and discusses the trends in fiscal debts and deficits and their potential impact on military spending. Second, it discusses the impact of the shift in defense priorities toward irregular warfare and

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II. The Impact of the US Fiscal Landscape on the Defense Industrial Base

The US is facing the challenges of increased US debt and widening deficits, partially due to its efforts to stem the financial crisis and to re-stimulate the economy in the recent period of slow economic growth. Efforts to reduce the US debt and deficit over time may put pressure on other areas of the budget, such as defense spending.

The US deficit for FY 2009 was $1.4 trillion, which was 9.9% of GDP (Calmes, 2010). President Obama's budget, submitted to Congress in early February, 2010, would result in a $1.56 trillion deficit, which is the highest level in history (Neefus, 2010). The deficit has only climbed to 5% or more of GDP four times since the end of World War II (Weisman, 2010). The Congressional Budget Office (CBO) has suggested that the annual deficits in the US could result in a national debt which is equal to the value of the nation's entire economic output by 2020 (Calmes, 2010).

As is evident in Figure 1, the ratio of gross federal debt to GDP rose from 57.3% in 2000 to 69.2% in 2008 to 83.4% in 2009. The Office of Management and Budget (OMB) projections suggest that it will continue to rise as a percentage of GDP over the next several years.

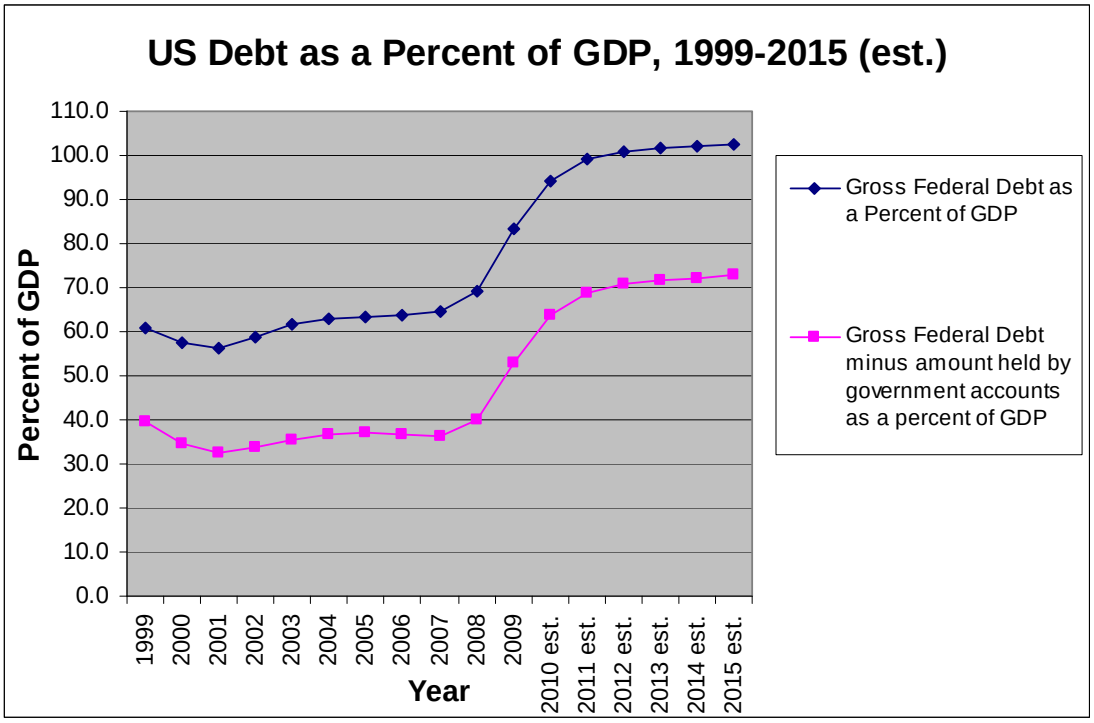

Figure 1. US Debt as a Percent of GDP, 1999-2015 (est.)
Source of underlying raw data in this graph: The President's Budget FY 2011, Table 7.1, http://www.whitehouse.gov/omb/budget

Figure 2 shows the historical trends in government spending, federal payments to individuals, and defense spending over the past fifty years. Government spending as a percentage of GDP has risen over time, with a significant increase during 2008-2009. Similarly, federal payments to individuals have risen as a percent of GDP during the past fifty years, with the introduction of many of the "Great Society" programs in the 1960's, and have also exhibited a significant increase during 2008-2009. Defense spending has declined over this period; it peaked at 14% of GDP in 1952, but has been below 10% of GDP every year since 1968. Defense spending was at or above 10% of GDP every year from 1952 through 1962 (except for 1961, when it was 9.9%). Over the past twenty years, defense spending has risen and fallen as a percentage of GDP. Defense spending fell from 5.8% of GDP in 1989 to 3.1% in 2001, due to the end of the Cold War, then experienced an increase with the Global War on Terror such that, by 2009, it was 4.9%. Consequently, although defense spending can be impacted by the aggregate size of

the federal budget, it is also strongly affected by the strength of immediate or potential military threats.

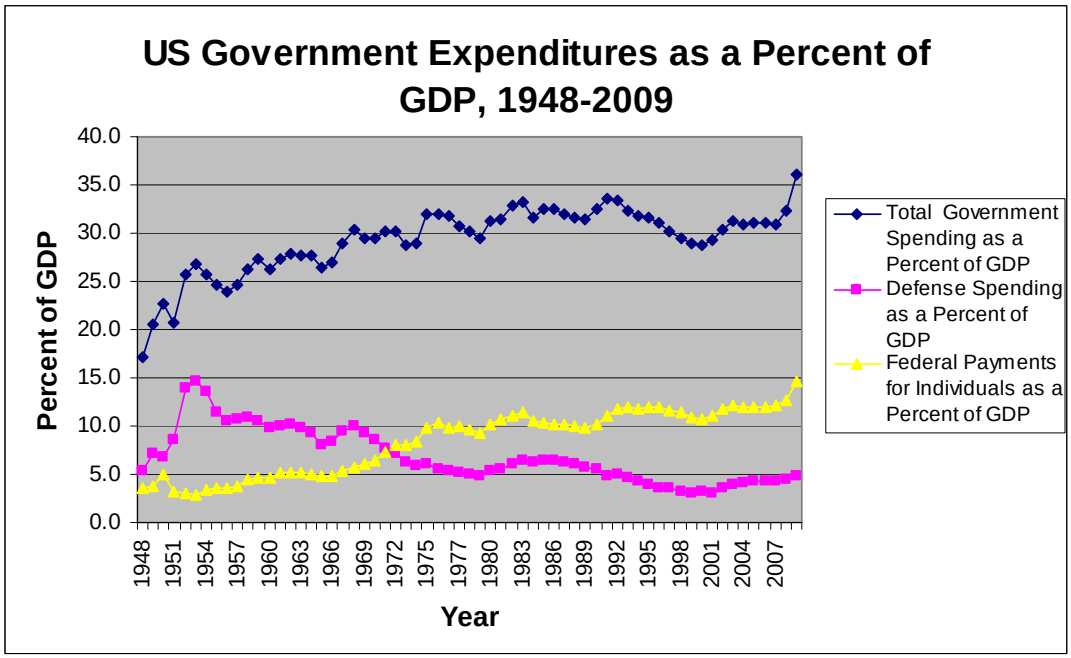

Figure 2. US Government Expenditures as a Percent of GDP, 1948-2009
Source of underlying raw data in this graph: The President's Budget FY 2011, Table 15.5, http://www.whitehouse.gov/omb/budget

The Congressional Budget Office (CBO) projects that US defense outlays as a percentage of GDP will fall over the next ten years, and that the interest payments on debt will increase as a percentage of GDP. Figures 3 and 4 show these projected trends as a percentage of GDP and in dollars.

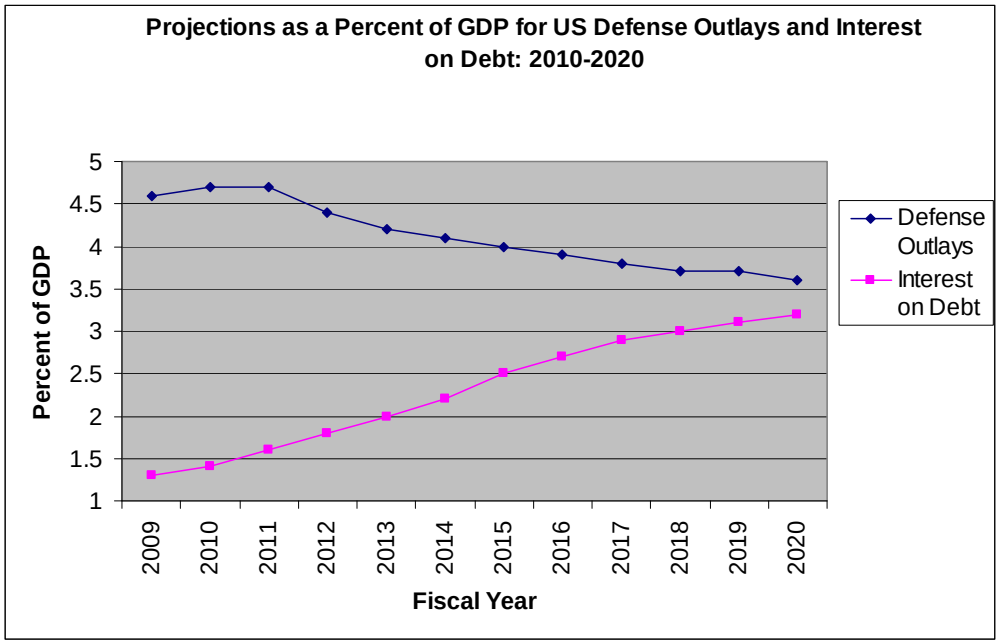

Figure 3. Projections as a Percent of GDP for US Defense Outlays and Interest on Debt: 2010-2020

Source of underlying data: the *Congressional Budget Office's Budget and Economic Outlook: Fiscal Years 2010 to 2020*, Table 3-1, p.48.

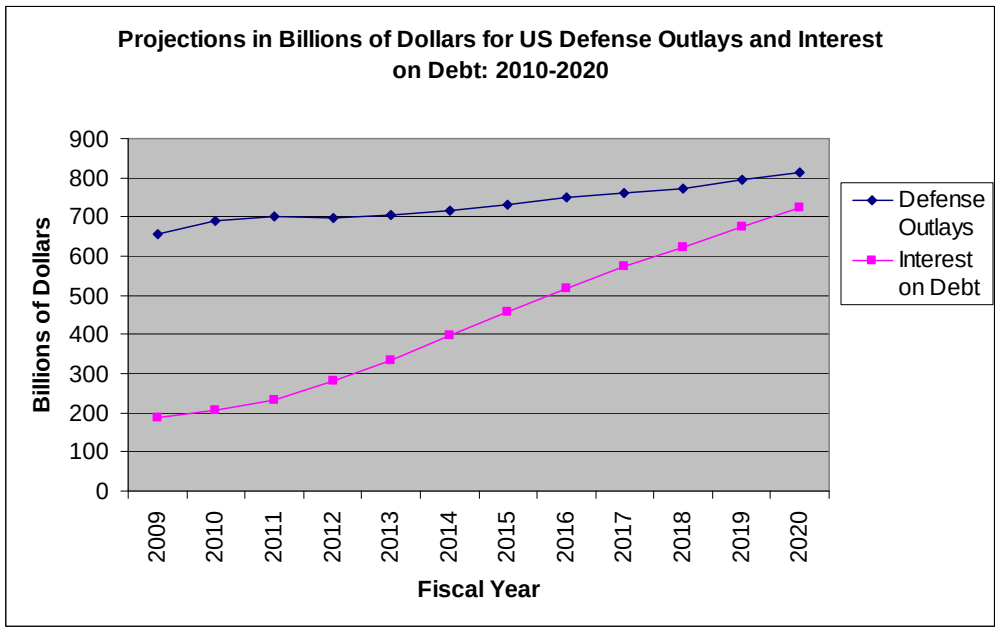

Figure 4. Projections in Billions of Dollars for US Defense Outlays and Interest on Debt: 2010-2020

Source of underlying data: the *Congressional Budget Office's Budget and Economic Outlook: Fiscal Years 2010 to 2020*, Table 3-1, p.4 8.

The US military is being reshaped to combat insurgent foes through irregular warfare, rather than to engage in combat against more traditional foes (superpowers). This shift in perspective has been reflected in recent Department of Defense (DoD) budget requests. As of February, 2010, the Obama administration sought $708 billion in FY 2011 for DoD. It included greater funding for unmanned aerial vehicles, a reduction in more high-tech weapons systems, and an emphasis on cost growth—particularly an end to production of the C-17 and the second engine design (from GE and Rolls Royce) for the F-35. The base budget request was $548.9 billion, which was 3.4% higher than in 2010. The largest increase in spending was in the operations and maintenance account, which is used for pay, fuel, etc, and which was to rise 8.5% to $200.2 billion. Funding for military hardware was to rise to $112.9 billion—an increase of 7.7%. This was to include purchases of UAV's from General Atomics, and helicopters from Sikorsky (United Technologies) and Boeing. The F-35 was the largest single program at $10.9 billion (Cole, 2010, February 17). It is likely that the pace of cutting expensive or poorly performing weapons development programs may slow over the next few years, since the significant ones have already been targeted (Cole, 2010). The Quadrennial Defense Review (QDR) has also emphasized more fuel efficient armored vehicles, unmanned drones, helicopters (Cole and Dreazen, 2010).

The shift in defense priorities and hard budget constraints can lead to the evolution of the defense industrial base and the attenuation of certain product areas. One example of the impact of hard budget constraints and shifting defense priorities on the elimination of a program is the F-22. The original concept for an advanced tactical fighter was conceived in 1981 during the Cold War, but the first F-22 actually entered USAF service at the end of 2005. Its original purpose was to field air-to-air combat in a traditional warfare situation so that solders on the ground would not be impacted by aerial attacks from the enemy and bombers could reach their target. The wars in Iraq and Afghanistan are different in that the enemy is an insurgent force, not a modern nation-state, and in that there are few strategic targets and no

opposing Air Force. As a result, the role of airpower is largely to protect troops on the ground and to airlift supplies. The Air Force already had 183 planes and four on the way. It wanted 20 more planes ($4 billion) for 2010 and hoped to have a total of 387 by the end of the decade. The Air Force studies justifying the 387 planes were based on the assumption that the US should be prepared to fight two major wars at the same time with foes that had similarly modern air forces. Consequently, it was concluded that the F-35, which is smaller and cheaper, could do a better job at destroying surface-to-air missiles, although not quite as good a job at shooting down planes. On July 17, 2009, the Senate voted (58-40) to end the F-22 program. This is likely to have a substantive impact on the defense industrial base because the F-22's contracts and subcontracts impact 46 states (Kaplan, 2009).

III. The Impact of Defense Spending and the Defense Industrial Base on Regional Economies

Although 2009 defense spending was only 4.9% of GDP, the defense presence in regional economies has strong spillover effects and can lead to substantive development of skills in the local labor market.

Washington DC is an example of an area where defense spending has strong regional spillover effects and where reductions in defense spending can affect local labor market conditions. Federal spending in the DC area rose from 33% of the spending in the regional economy in 2000 to 37% in 2010. The volume of defense procurement contracts in the area rose from $12 billion to $35 billion between 2000 and 2010. Many defense contractors exhibited significant growth; for example, General Dynamics, headquartered in Falls Church, VA, expanded from 1100 local employees in 2000 to nearly 6000 by 2005. Similarly, Arlington-based CACI International had 2600 area employees in 2001 and now has close to 6200 (Censer & Whoriskey, 2010).

Charleston, SC is a second example of an area where defense spending has strongly impacted the region. Many MRAPs are built by manufacturers based in Charleston (Force Protection) and some of the technology is developed by companies in the area (SAIC and SCRA). The MRAPs are outfitted with technology at Charleston's Space and Naval Warfare Systems Center. Between 2000 and 2007, IT employment in the area grew 52% , while it only grew 9% nationally. The growth in engineers, architects, and scientists grew 52% in this area, but fell 3% nationally. As a result, partially due to defense spending, South Carolina is second only to Michigan in its concentration of industrial engineers ("Charleston: A Turn in the South," 2009).

A third example is the impact that the Northrop/ EADS proposal which won the 2008 aerial refueling tanker competition, would have had on Alabama. Airbus planned to assemble the A330 freighter and the KC-45 in a $600 million plant in Mobile, bringing 1500 jobs to the city and stimulating $360 million in economic activity (Binns, 2008).

In the current environment of sustained, high unemployment, Congressional representatives have become increasingly concerned about the labor market impacts of reducing certain defense programs. The development of an industrial base across many states by a defense contractor for a particular system can be a strategy for survival because, especially in the current labor markets, it can mobilize Congressional representatives to encourage preservation of the weapons system.

For example, the C-17 Globemasters are large cargo planes produced by Boeing which cost about $250 million each. They have been used extensively for transportation of troops and supplies since 1993. The Pentagon has indicated little need for new C-17's every year since 2006, but Congress continues to authorize funds for the planes. The C-17 is manufactured in 43 states and employs 30,000 workers. Senator Boxer had encouraged funding for the plane—the Long Beach C-17 assembly plant employs 5000. About 650 suppliers are supported, and the impact of closing the line has been estimated to be $5.8 billion per year (Elgin and Epstein, 2009). Boeing has noted that C-17 line closure would be the end of the "last large military-jet aircraft production line in the US," and noted that Europe would then be the suppliers (Butler and Norris, 2009). Nevertheless, what will be the impact on skill sets and labor markets if the C-17 were terminated and, in later time periods, the US needed more than its current fleet of 223 C-17's and 111 C-5's? ("DoD Brass," 2010). Can commercial wide-body aircraft production capability be adapted to military needs, if necessary?

IV. Areas of Growth and Shrinkage in the Defense Industrial Base

There are concerns that a gap in work from the termination of certain types of defense programs could lead to the atrophy of a specialized skills base, which, in the absence of defense work, would not be able to grow with commercial sector demand. For example, although current profits may be good in particular sub-sectors due to orders of existing models, reduced demand for next generation Pentagon programs can reduce the growth of design teams, which can hinder the strength of the sector in developing future systems.

One example is the concerns over the industrial base for large body solid rocket motors (SRM's). Several US companies a few decades ago were involved in the solid rocket motor (SRM) space: Hercules, Atlantic Research Corporation, Thiokol, Aerojet, and the United Technology Corp's Chemical Systems Decision (Butler & Morring, 2009). ATK and Aerojet are the two prime contractors in this space today. ATK has most of the DoD and NASA production contracts for large SRM's, with Aerojet's work stemming from the USAF's R&D program. Aerojet and ATK share the small SRM production work. If there are no new development programs for the space sector, the SRM industry could lose its ability to produce the next generation (Butler & Morring, 2009). The sustainment of the Air Force's Minuteman III program and the Navy's Trident II D5 program at a low level has helped to maintain the SRM industrial base, but a gap in skills is developing ("US Solid Rocket Motor Industry," 2009; "Lawmakers Call on DoD," 2010). President Obama's FY 2011 NASA budget request called for the elimination of the Constellation (a space shuttle replacement effort) that included the developmental Ares I launch vehicle, the Orion crew capsule, and the future Ares V heavy lift rocket ("Solid Rocket Motor Industry," 2010). Although the fate of the Constellation program and its related programs is unclear as of this writing, if the program were eliminated,

there may not be enough business to sustain 2 large SRM producers, which could lead to further consolidation in the industry.

Certain areas of the defense industrial base are also exhibiting growth, with the shift in defense priorities. The UAV market, for example, is estimated to be worth $62 billion over the next 10 years and the wars in Iraq and Afghanistan have shown the potential for this market ("Teal Group," 2009). At the beginning of the war, the unmanned systems made up about 4% of the Army's flying hours; now, they make up 40%. In 2007, UAV's were performing 21 combat air patrols at any one time—a total of 100,000 hours. Forecasts suggest that by 2011, they will reach 350,000 hours and 54 patrols (Kaplan, 2009). UAV's have lower purchase costs (less extensive electronics systems than manned aircraft), lower operating costs (less fuel, don't need a lot of logistics support, don't need big runways, and require less pilot training), as well as less personnel risk (Cole, 2009).

The UAV market has provided opportunities for smaller, innovative, younger firms, as well as for more established defense contractors, which are expanding into the product space partially through acquisitions. Some examples of the smaller firms include General Atomics, which makes the Predator and Reaper planes; Aerovironment, which makes the Raven and is also developing the Global Observer platform; the UK developer Qinetiq, which has been developing an ultra long duration, high altitude UAS called Zephyr; and the Israeli UAS platform maker Elbit. Larger firms are also involved in this space, partially by enhancing their capabilities and reinforcing their skill sets through acquisitions of smaller firms. For example, Northrop Grumman, which produces the Global Hawk, acquired some of its capabilities from its acquisition of Ryan Aeronautics, which had expertise in target drone production and design. Northrop also bought Swift Engineering, which has expertise in designing blended wing UAV's. Rockwell Collins has become a significant supplier of avionics for unmanned and manned aircraft because it acquired Athena Technologies, a pioneer in flight control systems for UAV's, in 2004. Boeing acquired the Insitu Group in June, 2009, which originally designed the

ScanEagle UAV for tuna hunting, but turned more to defense after 9-11. Boeing's UAV business includes the A160T autonomous helicopter and the Phantom Ray unmanned combat aircraft demonstrator; Boeing's acquisition of Frontier, an unmanned helicopter developer, helped in developing its knowledge pool in this area (Warwick, 2009).

UAV's are stimulating other, related areas of the defense industrial base. For example, sensors are being designed around the constraints and advantages of UAV's. One example is the Forester foliage-penetration radar flown on the A160T takes advantage of the long endurance, high altitude and precise low speed control of unmanned helicopters. A second example is the Artemis 25-Ghz radar for Northrop's unmanned helicopter, the MQ-8B Fire Scout. Use of unmanned aircraft in Afghanistan and Iraq have led to increased demand for full motion video, such as the Gorgon Stare wide-area airborne surveillance pod on MQ-9 Reaper (Warwick, 2009).

Propulsion systems for UAV's are another area of development since most of the engines have their origins in either non-aviation markets or manned aircraft. Solar cells and advanced batteries may be the engines for longer-endurance aircraft such as Qinetiq's Zephyr. Liquid hydrogen is also considered as a source of power for high altitude UAV's like the Global Observer (AeroVironment). Modifications for the hand-launched UAS's, such as Aerovironment's Raven B, to use hybrid fuel cell / battery powerpacks are in progress (Warwick, 2009).

Consequently, while certain areas of the defense industrial base are experiencing attenuation in skill sets, new market areas and skill sets are developing. Market entry opportunities exist for newer firms in these segments, unlike traditional market segments, such as fighter jets, due to lower barriers to entry, lower fixed costs.

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V. The Impact of Overhead Costs for Large, Defense Contractors on their Competitive Advantage

As new areas of development of the defense industrial base result in larger, traditional firms competing with smaller, younger firms, can traditional prime contractors maintain the low cost and rapid innovation needed for this market? With the impact of potential defense cuts of larger, traditional systems, will they have to raise rates to support their overhead base and will they lose their cost-based competitive advantage in competing with smaller, younger firms?

One example of a force which could lead to a substantive increase in overhead rates for older, traditional, defense contractors is the impact on their overhead costs of funding their pensions, which are significantly underfunded. Younger firms have fewer retired workers and fewer defined benefit pension obligations. This could impact the ability of larger firms to maintain a sustained cost-based competitive advantage in areas of growth in the defense industrial base.

As of the spring of 2010, the Defense Contract Management Agency (DCMA) forecast that major prime contractors would experience an increase of $53 billion in pension costs between 2010 and 2016. Part of this is due to the degree to which pension plans are underfunded—the result of an increase in pension obligations and the sensitivity of pension assets to the movements in the financial market. Part of this is also due to the implementation of the Pension Protection Act (PPA) of 2006, which required that a pension plan be fully funded. Due to implementation of the PPA, defense contractors have anticipated greater funding requirements beginning in 2011; indeed, Lockheed Martin's 10-K (Lockheed Martin, 2010b) and General Dynamics' 10-K (General Dynamics, 2010b) specifically stated this. Large defense contractors with revenues in excess of $5 billion were given until January 1, 2011 to implement the PPA and are waiting for guidance on how the PPA will be harmonized

with the US Government Cost Accounting Standards (CAS). CAS 412/ 413 require that the pension costs of a contractor can be allocated to government contracts, such that the pension costs can be recovered as allowable costs. This may significantly impact the Department of Defense in terms of higher rates on weapons products from defense contractors, both because of the higher pension costs for defense contractors due to the need to fully fund pension plans under the PPA, and also because of the degree to which these costs are allowable and hence recoverable. As Northrop Grumman's 10K of February 9, 2010 noted, "contractors will be entitled to seek an equitable adjustment for the additional CAS contract costs required" (Northrop Grumman, 2010b) and, as General Dynamics' 10-K (General Dynamics, 2010b) noted, "our contractual arrangements with the US government provide for the recovery of contributions to our pension plans covering employees working in our government contracting business."

Figure 5 suggests that the present value of pension obligations rose over time for all five contractors, although the relative ordering of the magnitudes remained roughly stable. Boeing had the most substantial pension obligations, followed by Lockheed Martin, while General Dynamics had the least substantial pension obligations.

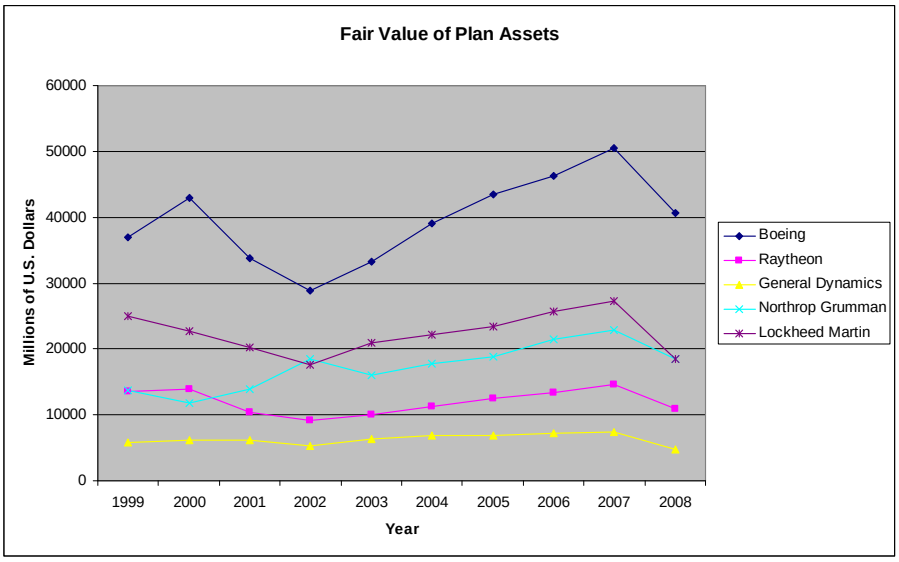

Figure 5. Fair Value of Plan Assets
Source of data in the graph: Capital IQ database

Figure 6 shows that the fair value of pension plan assets fell between 1999 and 2002 for 4 of the 5 contractors, increased between 2002 and 2007, and then fell between 2007 and 2008. Not surprisingly, Boeing consistently had the highest fair value of pension assets (since it had the most significant obligations) and General Dynamics had the lowest value of pension assets. All of the defense contractors experienced an increase in the value of their pension assets in 2009, returning to levels similar to 2007.

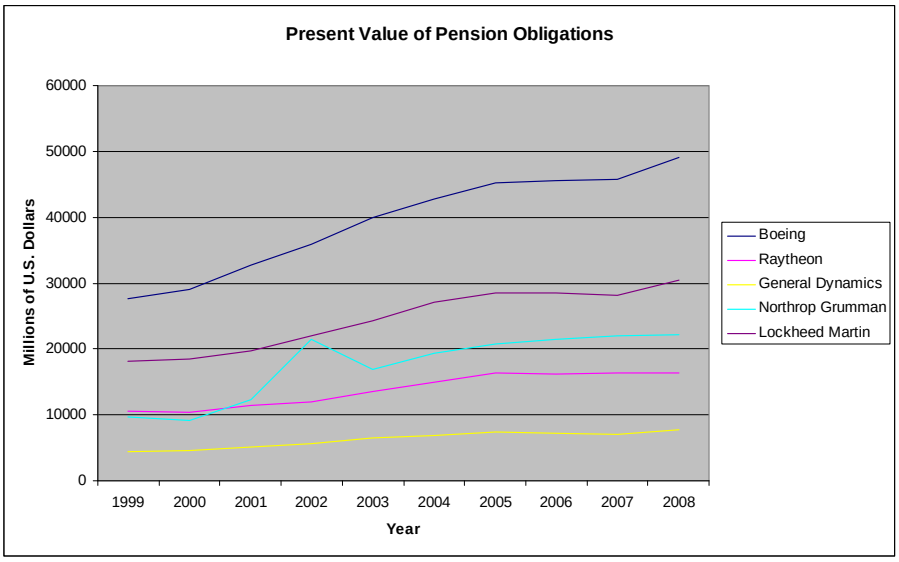

Figure 6. Present Value of Pension Obligations
Source of data in the graph: Capital IQ database

Figure 7 shows the degree of funding or underfunding of pensions (the degree to which assets exceed obligations) over time. All five defense contractors experienced declining funding status between 1999 and 2001 such that, by 2002, all of the plans were underfunded. Some of the plans, such as Boeing's, experienced some improvement in their funding status between 2002 and 2007, but then fell sharply between 2007 and 2008 as the markets in which the pension fund assets were invested declined. General Dynamics and Northrop Grumman have among the most well-funded pension plans as measured by the magnitude of the gap between assets and obligations, and Lockheed Martin and Boeing have the most underfunded pension plans.

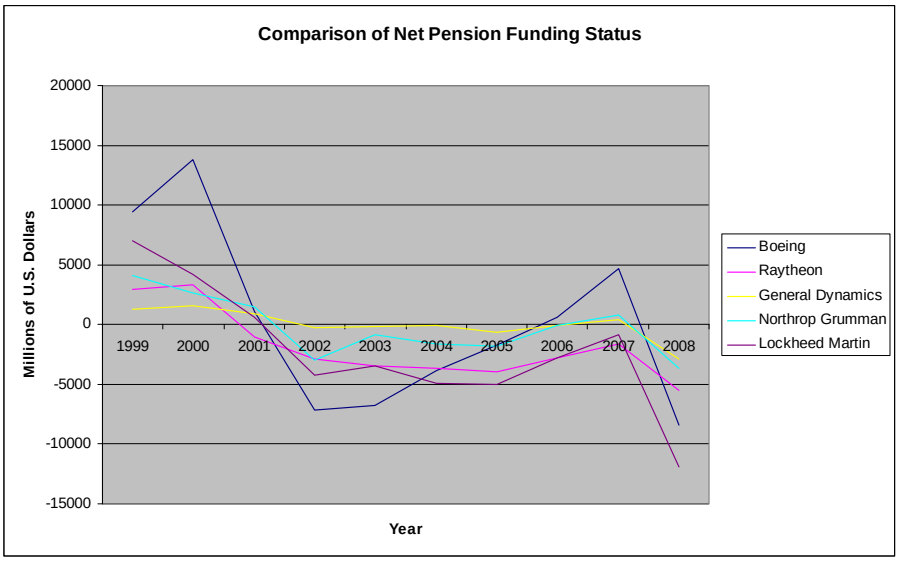

Figure 7. Comparison of Net Pension Funding Status
Source of data in the graph: Capital IQ database

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VI. The Impact of Shifting Defense Priorities on the Business Base and Financial Health of Defense Contractors

In an effort to shift their business base toward areas of growth to generate profits as well as to cover overhead costs (including previously incurred pension costs), defense contractors are focusing more on the types of equipment which are currently in demand, thus leading to growth in some areas of the defense industrial base and to contraction in other areas.

Figure 8 shows the trend in net income margins of defense contractors over the past decade; net income margins were declining for many of the defense contractors prior to the initiation of the Global War on Terror, and then they experienced an increase. Since 2007 (or 2008, depending on the contractor), the defense contractors have experienced declining margins or a decline in margins, followed by an increase.

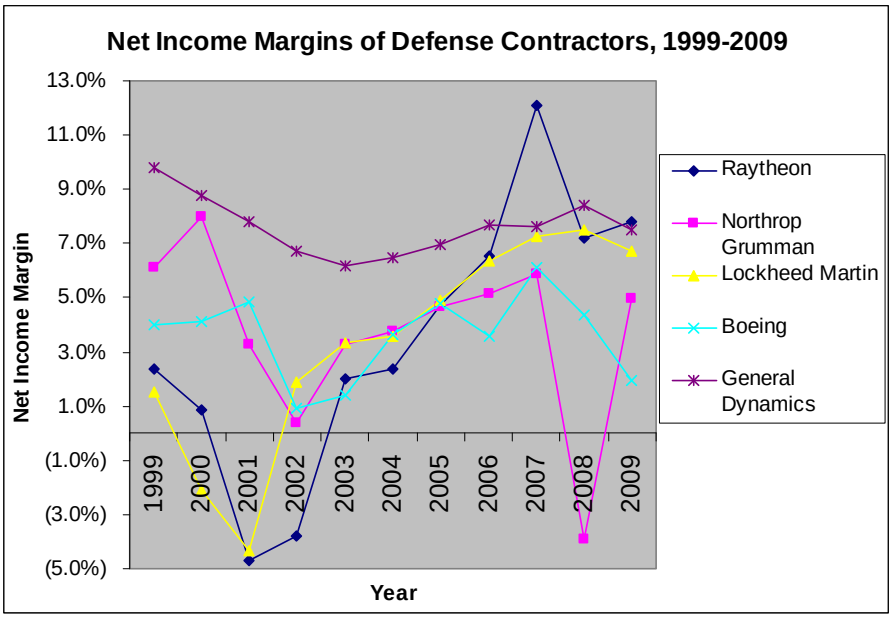

Figure 8. Net Income Margins of Defense Contractors, 1999-2009
Source of underlying raw data in the graph: Capital IQ

The impact of shifts in business base in response to evolving defense priorities is evident in the second quarter earnings and projections of the defense contractors. For example, Lockheed Martin's second quarter profit increased 12% relative to last year. The largest unit of Lockheed Martin, the electronic systems unit, experienced an increase in revenues of 3.9% and an increase of 1.6% in earnings due to improved sales of sensors, missiles, and fire control systems. Its aeronautics group experienced a 6.8% fall in earnings partially due to less volume on the F-22, F-16, and F-35 contracts (Lockheed Martin, 2010c). Similarly, General Dynamics's second quarter profit grew at 4.9%. Its information technology segment, its largest segment, exhibited a 12% increase in sales. The aerospace group exhibited higher operating margins, despite reduced sales, and the company was optimistic about the increase in orders for Gulfstream business jets on the commercial aircraft side (General Dynamics, 2010c).

Northrop Grumman's recent decisions have emphasized the need for synergy in an environment of fiscal austerity and shifting areas of focus in defense markets. Northrop Grumman's second quarter earnings rose 81% because sales increased in four of its five divisions. Due to increased demand for unmanned and manned aircraft, Northrop Grumman's earnings in its aerospace division increased 30% from the second quarter of last year.

Northrop Grumman is moving toward the divestiture of its shipbuilding unit, due to a lack of synergies with its other units, and plans to focus more on its information systems, unmanned aircraft, and electronics businesses (Pfeiffer, 2010d). It plans to close the Avondale shipyard in Louisiana which supports 5000 direct jobs and 6500 indirect jobs by 2013 and to consolidate production of the remaining two ships in the LPD-17 class at its Ingalls shipyard in Pascagoula to reduce overhead and to generate improved efficiencies and lower production costs. The shipbuilding unit currently includes the Newport News shipyard, in addition to the Avondale and Ingalls shipyards. Newport News is the sole manufacturer of

nuclear-powered aircraft carriers and one of two shipyards which builds nuclear-powered submarines for the Navy ("Northrop CEO," 2010; Frost, 2010; Schmidt, 2010). Consequently, purchase of the unit by a foreign buyer may have complexities. Other possibilities include private equity firms as buyers, or another defense firm, such as General Dynamics. General Dynamics owns the other three major military shipyards—Bath Ironworks, Electric Boat, and NASSCO—and ran into antitrust difficulties when it attempted to purchase Newport News prior to Northrop Grumman's purchase of it in 2001.

Figure 9 shows the declining trend over time in shipbuilding and marine systems as a percentage of total revenue for the two major US military shipbuilders—General Dynamics and Northrop Grumman (which entered the industry in 2001). Figure 9 also highlights the greater share of marine services for General Dynamics in most years relative to the share of shipbuilding in Northrop Grumman's revenue.

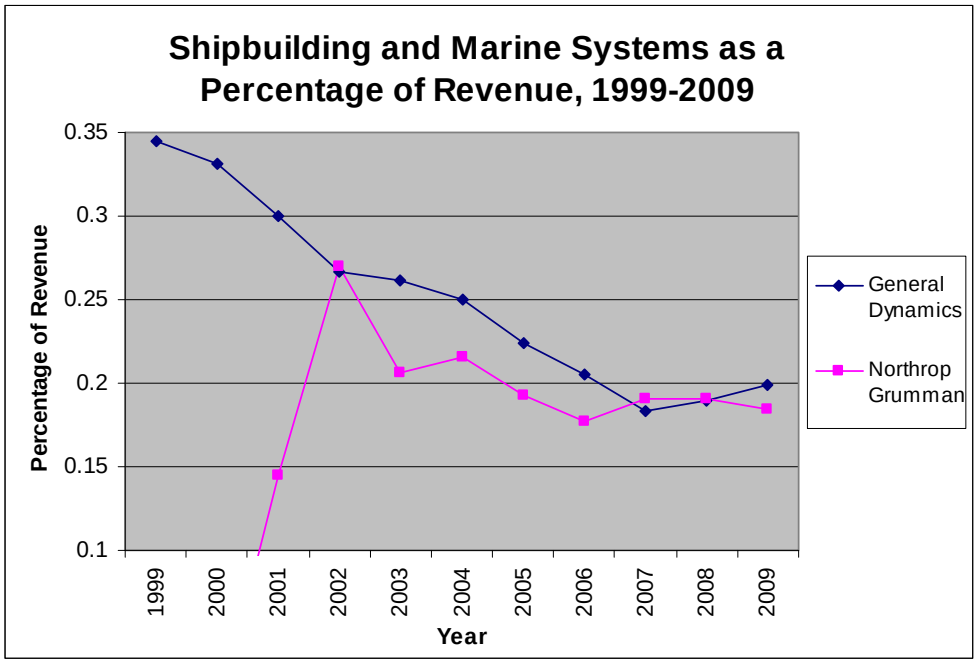

Figure 9. Shipbuilding and Marine Systems as a Percentage of Revenue, 1999-2009

Source of underlying raw data in the graph: Capital IQ database

Defense contractors involved in production of commercial aircraft, such as Boeing and EADS, have experienced increased demand for commercial aircraft, which may bolster profits if military sales decline. Diversification of their business base will assist them in responding to shifts in the defense industrial base. Although EADS reported a net profit of 185 million euros for the first two quarters of 2010, which was half of the profit that it had reported for the first two quarters of 2009, it was optimistic about the future outlook due to the surprising recovery in the civil aviation market, as evidenced by increased orders at the Farnborough Air show. Despite potentially declining orders in the military markets, production in the commercial aircraft market through Airbus, EADS' commercial division, helps to diversify risk (Pearson, 2010).

Boeing, which obtains 43% of its revenue from US government contracts and is more diversified on the commercial side than other defense contractors, was similarly favorably surprised by the increased orders for commercial jets. Boeing's second quarter earnings fell 21%: the defense segment's operating margin in the second quarter fell 1.2 percentage points to 8.9% because of the decline in revenues from all defense units except aircraft. This decline was even greater than the decline in the operating margin exhibited by the commercial jet division, where the decline in the operating margin was 0.5 percentage points, falling to 9.2%. Boeing reduced its forecast for its defense unit's operating margin by half a percentage point for 2010 and may undertake layoffs (Ray, 2010).

The 100-149 seat jet market, which includes Boeing 737's and Airbus A320's, is likely to be worth $360 billion over the next twenty years (P.Clark, 2010). Boeing predicted that almost 70% of its commercial aircraft sales over the next two decades would be single aisle aircraft similar in capacity to the 737's and the A320's (N. Clark, 2010). At the Farnborough Air Show in late July, there was increasing demand for mid-size passenger jets, many of which were purchased by aircraft

leasing companies. For example, Air Lease Corporation purchased 60 single- aisle Boeing 737's to lease to budget airlines, as well as 51 A320's and 20 jets from Brazil's Embraer group (P. Clark, 2010). Lessors owned 23% of jetliners in 1990, and now own over 33% of them (Michaels, 2010).

Monthly production rates for the 737 will increase for Boeing; they currently complete production on one 737 per day, but they hope to produce 35 per month by 2012 (Pfeiffer & Clark, 2010a); similarly, Airbus, the commercial unit of EADS, announced that it would increase output of single aisle jets to 38 per month by the third quarter of 2011 and to 40 per month by the first quarter of 2012. Competition from other manufacturers is likely to increase in this sub-market: for example, Bombardier has been developing the CSeries (due to be released in 2013) to compete with the A320 and the 737. The CSeries will also compete with the C919, to be released in 2016, which is manufactured by the Commercial Aircraft Corporation of China (P. Clark, 2010).

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VII. The Role of Fiscal and Economic Constraints on Interdependencies in the Global Defense Industrial Base

Defense Secretary Robert Gates stated that “defense manufacturing is a global business.” Similarly, Dr, Ashton Carter, Undersecretary of Defense (AT&L), has noted that European products are “part of a ‘global industrial base’ that deserve consideration, especially if these designs can be purchased at a lower cost” (Butler, 2009). The interdependencies between US and foreign industrial bases are evident in a number of ways. For example, the littoral combat ships are being built in foreign-owned facilities in Mobile, AL (Austal) and Marinette, Wisconsin (Marinette Marine, owned by Fincantieri). About 75% of the helicopters used by Homeland Security were built in Italy, Germany, or France. About 80% of the mine-resistant vehicles ordered are based on vehicle designs from outside the US.

As Figure 10 shows, however, most of the large Department of Defense contracts are awarded to US firms as the lead contractor, with only a smaller percentage being awarded to foreign firms—a trend which has been relatively stable over the past five years.

	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008
Percentage by total volume of contracts						
US	0.969	0.97	0.964	0.976	0.979	0.973
Foreign	0.031	0.03	0.036	0.024	0.021	0.027
Percentage by total value of contracts						
US	0.985	0.98	0.976	0.976	0.985	0.982
Foreign	0.015	0.02	0.024	0.024	0.015	0.018

Figure 10. Percentage of Large Department of Defense Contracts Awarded to US firms as the Lead Contractor versus Foreign Firms
Sources of data: *Report Required by Section 812 of the National Defense Authorization Act for Fiscal Year 2004: Foreign Sources of Supply*, annual (Office of the Under Secretary of Defense, Acquisitions, Technology, and Logistics)

Nevertheless, although many US weapons systems do not have foreign contractors as the primary contractor, the US is involved with the defense industrial bases of other countries through global supply chain arrangements. The development of the Joint Strike Fighter (JSF) is an example of one of the most extensive global alliances in the defense sector. Secretary of Defense Robert Gates, in purchasing more JSF's, has emphasized the commitment of the US to systems which are compatible with its allies and which are developed through global alliances (Lockheed Martin, 2008). The F-35 involves 9 different contractors from various countries, led by Lockheed Martin, with Northrop Grumman and BAE as the primary subcontractors, and is supported by 600 suppliers in 30 countries ("Aerospace Production," 2009). The F-35 is intended to replace 13 different types of aircraft across 11 different countries (Lockheed Martin, 2008). The US plans to buy 2443 of these aircraft, and the UK, Turkey, and Italy also plan to buy hundreds of them, which will increase production to around 3000. The F-35 will take advantage of economies of scale in both production and continued operation: the Air Force,

Marines, and Navy's planes will be based on a common design, which will generate economies of scale in production, and which will use the same sustainment infrastructure worldwide.

The recent environment of fiscal austerity can, however, impact the success of these global supply chain arrangements in several ways. First, budget deficits in European countries can lead to reduced demand for military equipment, including purchases of the JSF and other defense products made through global supply chains. Second, exchange rate volatility can impact the profitability of global supply chain arrangements, as smaller European producers can become squeezed, and, as certain European financial markets weaken, their access to bank financing becomes even more limited.

Figure 11 shows the substantive increase in cross- country debt to GDP ratios between 1990 and 2009. All of the countries (even those which had exhibited a declining trend prior to the financial crisis, such as Canada) have experienced increases in their debt to GDP ratios as they have struggled to combat the financial crisis.

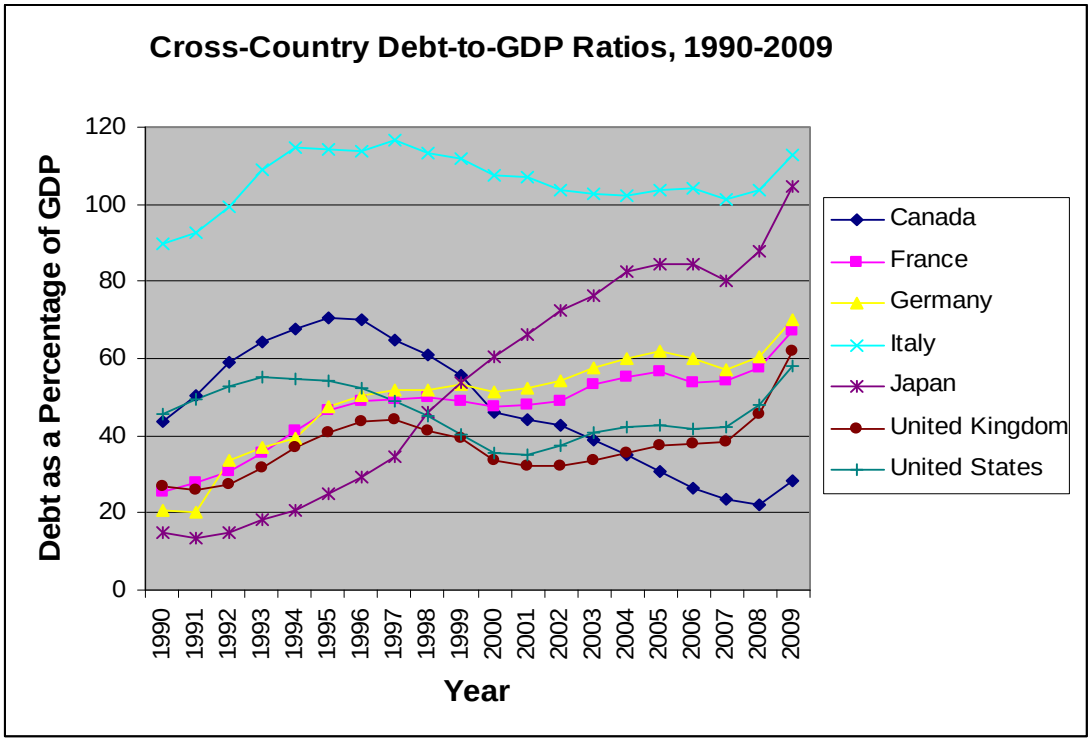

Figure 11. Cross-Country Debt-to-GDP Ratios, 1990-2009
Source of raw data in the graph: International Monetary Fund's World Economic Outlook Database

Figure 12 shows cross-country evidence on deficits as a percentage of GDP in 2009. Greece, for example, has a national debt equal to 113% of GDP and a deficit of 12.7% of GDP, which is much higher than the maximum of 3% allowed by the EU. Greece plans to undertake initiatives to reduce the deficit to 3% by 2012; similarly, Italy (whose debt is 113% of GDP), Portugal, Spain, and Ireland have high budget deficits. The upcoming budget austerity in the European countries to reduce national debt will ultimately impact their defense spending and have implications for the financial costs of their involvement in Iraq and Afghanistan, as well as for their spending on defense products made by American and European defense manufacturers.

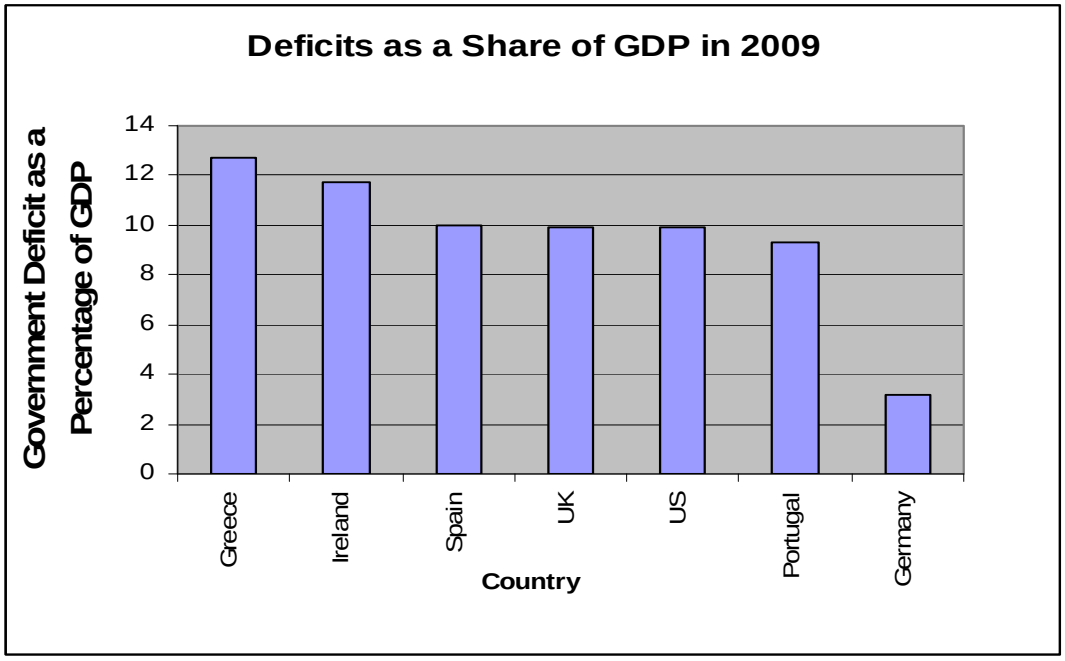

Figure 12. Deficits as a Share of GDP in 2009
Source of underlying raw data in the graph: Congressional Budget Office and the International Monetary Fund

For example, Germany plans to cut $10.5 billion from the defense budget by 2014. Spain cut defense spending by 9% this year, Italy will reduce defense spending by 10% next year, and France is freezing defense spending ("Defense spending," 2010). The UK, which is the largest European force in Afghanistan, may reduce defense spending by 10-20% over the next 5 years. The UK 's National Audit Office has suggested a 36 billion pound hole in the UK procurement budget over the next decade. Programs such as the F-35 (the UK is currently expected to buy 138 planes), a second aircraft carrier for the Royal Navy, and the final order of the Eurofighter Typhoon could be in jeopardy. In the UK, defense expenditures have declined from 4.4% of GDP in 1987 to 2.5% in 2007, while R&D spending has declined by a quarter over the past three years (Pfeiffer, 2010a).

The exchange rate volatility can also have a significant impact on the profitability of global supply chain arrangements. Figure 13 shows the volatility in the exchange

rate over the past year, as investors began moving away from the euro as concerns arose about the ability of European countries to combat their deficits.

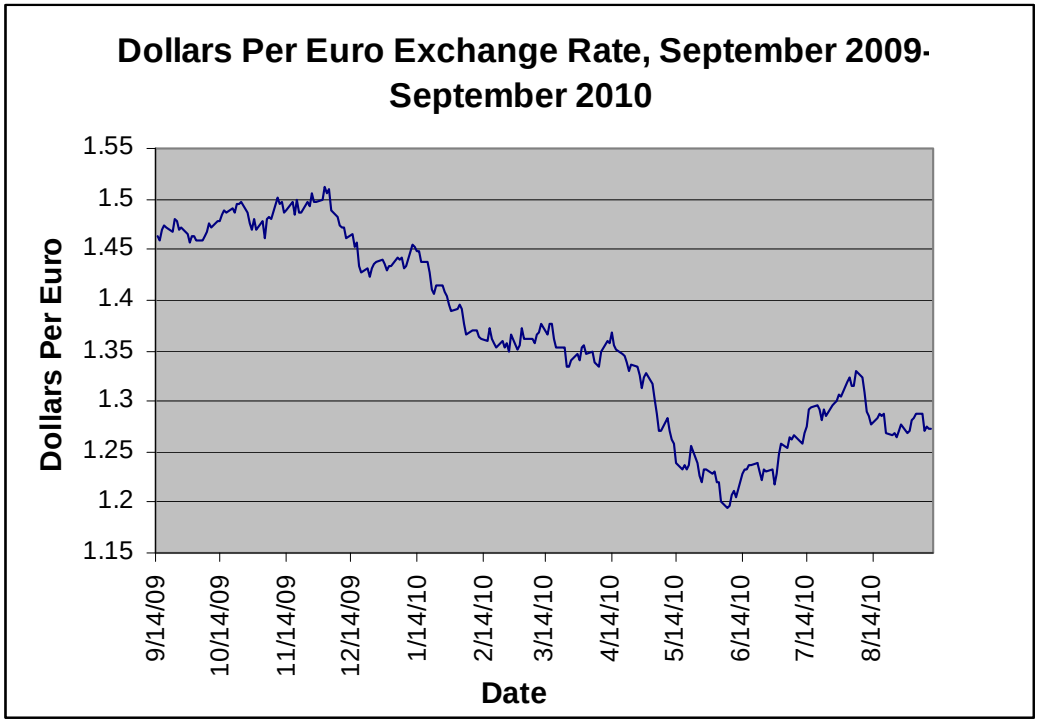

Figure 13. Dollars Per Euro Exchange Rate, September 2009-September 2010
Source of underlying raw data in the graph: Capital IQ database

Exchange rate fluctuations in the euro caused by the economic crisis can impact the growth of the global defense industrial base in terms of their impact on exports and imports of ships and aircraft by Europe. As is evident in Figures 14 and 15, the US, France, and Germany control 70.6% of global exports in the aircraft and spacecraft market; countries which are eurozone members—France, Germany, Italy, and Spain—control 38.7% of exports in this market. In the market for ships, the Republic of Korea, Japan, China, Germany, and Italy control over 65% of the export market; countries which are eurozone members—Germany, Italy, France, the Netherlands, and Finland—control 14.8% of exports in this market. Consequently, a

weakening euro is likely to make European exports of aircraft and ships more attractive to other non-European countries.

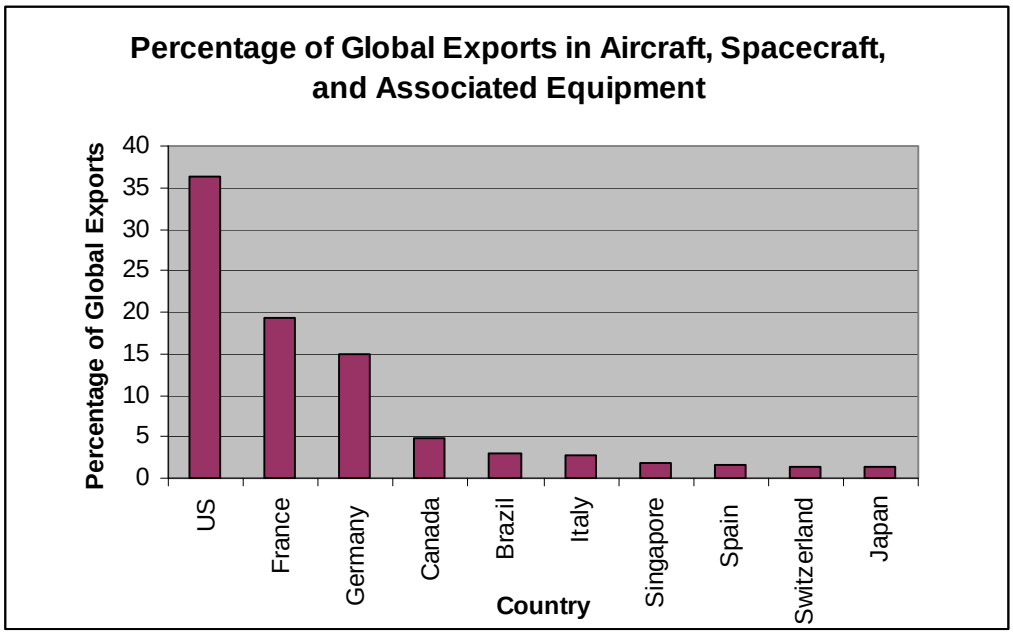

Figure 14. Percentage of Global Exports in Aircraft, Spacecraft, and Associated Equipment

Source of underlying raw data in the graph: *UN International Merchandise Trade Statistics, 2008*

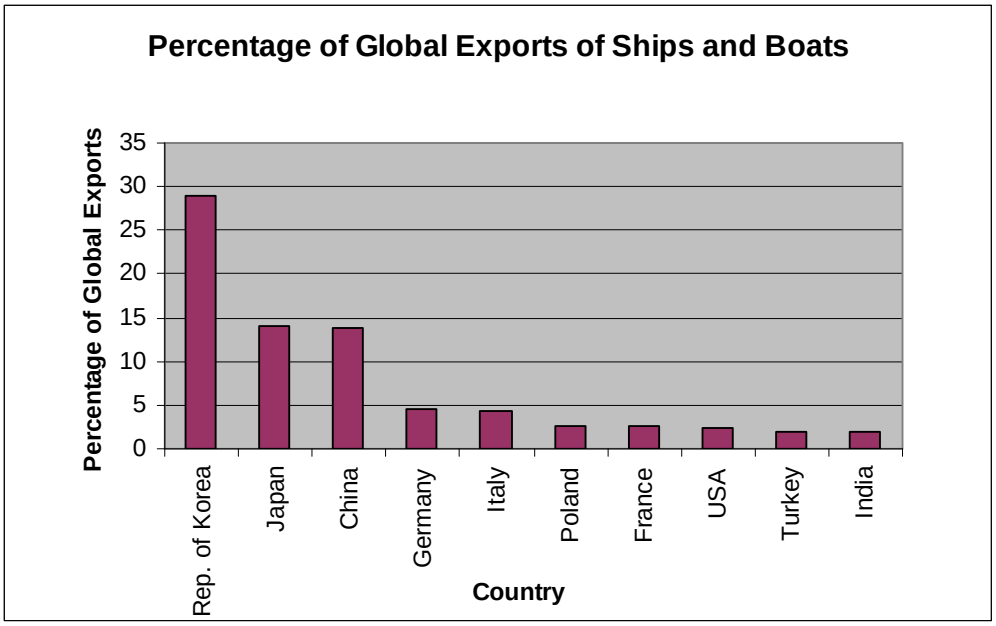

Figure 15. Percentage of Global Exports of Ships and Boats
Source of underlying raw data in the graph: *UN International Merchandise Trade Statistics, 2008*

As is shown in Figures 16 and 17, Germany, the US, France, India and China control almost 50% of global imports in the aircraft and spacecraft market; countries which are eurozone members—Germany, France, Italy, Spain, and Ireland—control 28.3% of imports in this market. The import market for ships is much more fragmented, with Germany, India, Norway, Italy and Greece controlling 36% of the market; countries which are eurozone members—Germany, Italy, Greece, and Belgium—control 25.2% of the market. Consequently, a weakening euro is likely to result in a reduced European demand for aircraft and ship imports, which can impact the industrial base and financial strength of the manufacturers in other countries.

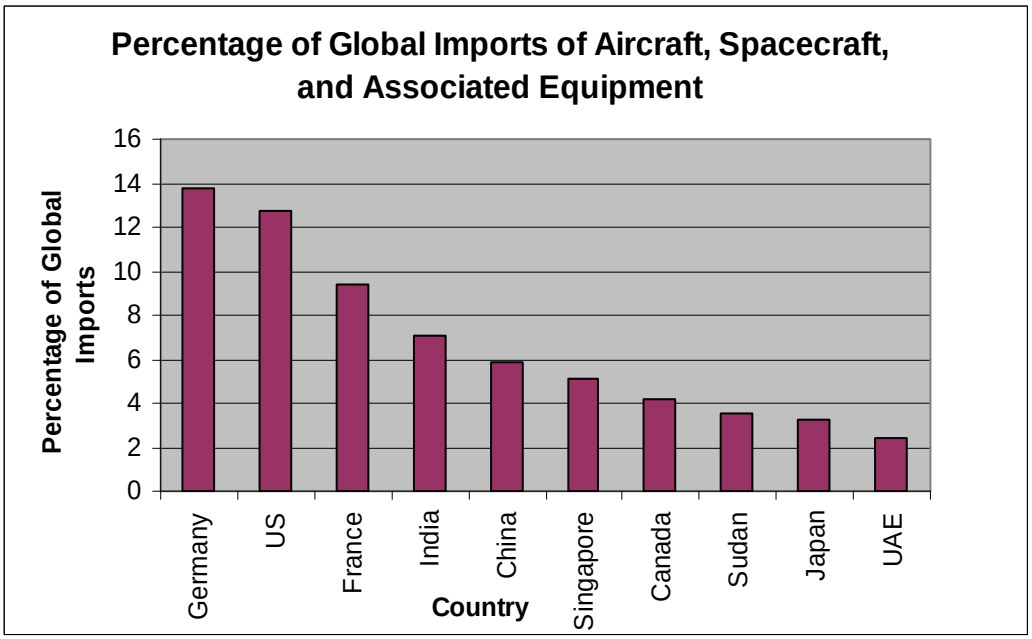

Figure 16. Percentage of Global Imports of Aircraft, Spacecraft, and Associate Equipment

Source of underlying data: *UN International Merchandise Trade Statistics, 2008*

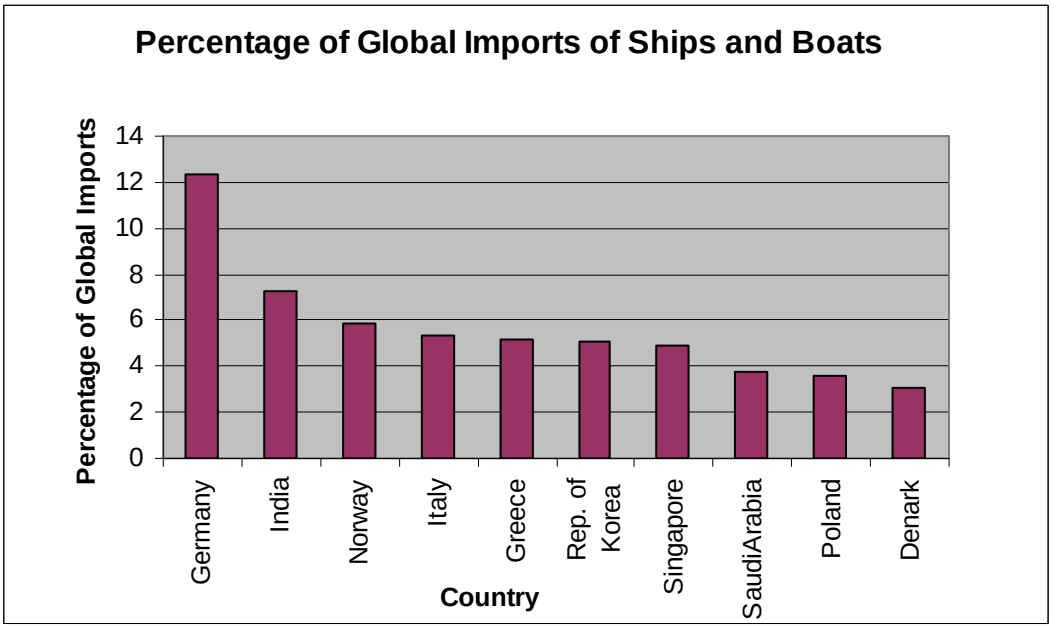

Figure 17. Percentage of Global Imports of Ships and Boats

Source of underlying data: *UN International Merchandise Trade Statistics, 2008*

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VIII. The Impact of the Evolving Strategic and Fiscal Landscape on the Areas of the Global Defense Industrial Base

The global defense industrial base is evolving across regions. The demand for traditional equipment is shrinking in the US and Europe due to reduced demand in US and European defense markets for traditional types of weapons systems used in conventional warfare, as well as the need to combat budget deficits and debt. Nevertheless, some regions, such as the Middle East and India, have growing defense budgets and consider their immediate threats to be modern nation states, thus increasing their demand for conventional weapons systems.

For example, between 2001 and 2008, Middle Eastern countries bought 50% of the arms purchased from the US. Defense spending in the Middle East is forecast to reach $100 billion in 2014—11% of global arms sales. Moreover, Saudi Arabia's defense spending has doubled between 2001 and 2008 to $43.52 billion (Bianchi, 2009). Similarly, over the next 5 years, India, which was the tenth largest spender on the military in 2008, plans to spend $50-$55 billion on equipment procurement to protect itself against potential threats, especially from China and Pakistan. Indeed, India's competition for an $11 billion contract for 126 fighter jets—the largest fighter jet competition since the 1990's—involves US, European, and Russian defense contractors, such as Saab, Dassault, Boeing, Eurofighter, RAC MiG (Russia), etc. (Lerner, 2010; Gulati, 2010; Misquitta, 2009; Blumenthal, 2010). The largest Indo-American defense deal so far is the (in process) $3.5 billion purchase of 10 C-17's, at the same period in history in which the Pentagon is recommending the end of the C-17 program. India bought 6 C-130 J's in 2007 for $962 billion, 8 Boeing P-8I aircraft for $2.1 billion in 2009, etc.

Not surprisingly, US and European defense contractors are targeting overseas markets and orienting those aspects of their industrial base which focus on

traditional equipment more toward overseas markets than they have done historically. Indeed, the market for replacement of military aircraft in countries such as Brazil, Switzerland, Denmark, Korea, and India could encompass 3345 aircraft and could collectively be worth $164 billion by 2017 (Lerner, 2010). Among the US contractors, Lockheed Martin plans to focus on overseas export sales to Asia and the Middle East, due to increased demand for F-16's, PAC-3 air-defense missile systems, and C-130 transport planes. Lockheed Martin plans to expand international defense sales, which are about 13% of 2009 sales, to nearly 20% of sales by 2013. Boeing also plans to expand international defense sales, which are about 16% of Boeing's 2009 defense revenues to 25% over the next 5 years (Pfeiffer & Clark, 2010b). Figure 18 shows the shares of revenue from commercial and military sales to foreign countries over the past three years across the top five defense contractors; Boeing is the most oriented toward the international market, while Northrop Grumman is the least oriented.

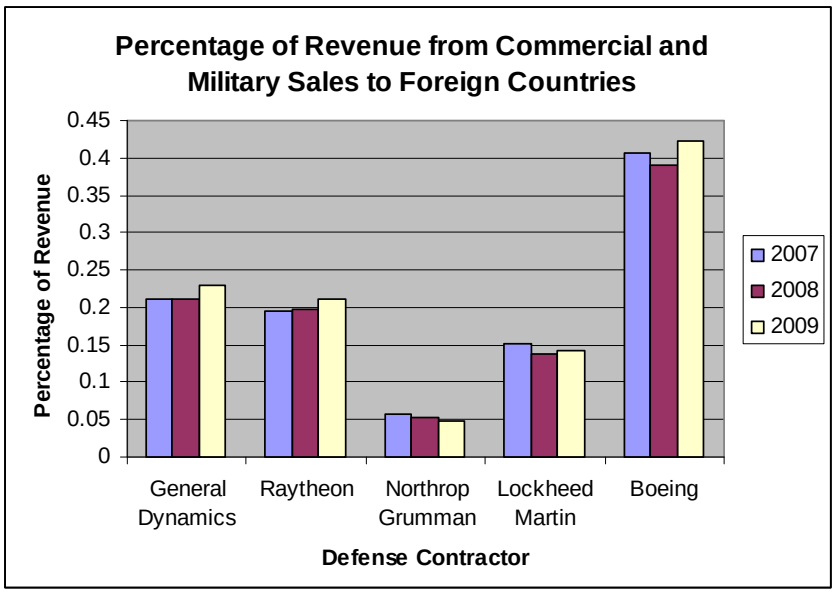

Figure 18. Percentage of Revenue from Commercial and Military Sales to Foreign Countries

Source of underlying raw data in this graph: 2009 annual reports for General Dynamics, Raytheon, Northrop Grumman, Lockheed Martin, and Boeing, as well as the Capital IQ Database

European defense contractors, such as EADS, BAE, and Finnmeccanica, are targeting markets beyond Europe. Indeed, Stefan Zoller, head of defense and security at EADS, recently noted that "European markets will decline or be stable at best…Strategically, we have to go where the money is and the money is around the globe." The company will have to "generate growth to maintain our industrial base at home." EADS is targeting markets such as Brazil (which experienced a 23% increase in military spending in 2009), the Middle East, and India. EADS plans to increase the share of its employees who are located outside Europe from 5% in 2009 to 20% in 2020 (Pfeiffer & Clark, 2010b). Finmeccanica (Italy), which has established a strong presence in the US and in the UK (where it owns BAE's former avionics group and Agusta Westland's helicopter group) is a second example. Finnmeccanica noted this March that it expected 50% of its orders in 2010 to come from outside the US, the UK, and Italy. Finnmeccanica is targeting India, the Middle East, Turkey, Algeria, Brazil, and Libya, as well as Russia. BAE is a third example; it only obtains 20% of its defense revenues from the UK (Pfeiffer, 2010b).

Overseas contracts and alliances between developing countries and defense contractors in developed countries could help to expand the defense industrial base in the developing countries. For example, in procuring defense equipment overseas, India also is trying to develop its own defense industrial base. Although it makes aircraft, land vehicles, and small arms, it is trying to develop more in the high tech equipment area of its domestic defense industrial base and hopes to reduce imports from 70% to 30% over the next decade as its own base develops. It engages in alliances with Western defense contractors to gain knowledge; examples include Mahindra Defense systems, which is in a $20 billion joint venture (since January 2009) with BAE to develop mine protected vehicles; Larsen & Toubro, which teamed with Raytheon in February 2010 to upgrade the Indian Army's Russian origin T-72 tanks, and Hindustan Aeronautics which is building the Hawk 132 Advanced Trainer Jet under license from BAE (Misquitta, 2009; Krishna, 2010).

A second avenue of expanding defense industrial bases in developing countries is through “offset agreements.” The global value of “offset” agreements, in which western defense contractors who have won defense contracts agree to directly or indirectly help to develop the industrial base of the purchasing country, are worth between $75 billion and $100 billion and require a certain percentage of the contract value to remain in the purchasing country. These agreements began after World War II and, since 1999, about 22 countries have developed formal “offset” legislation. Contractors consider “offsets” to be part of the cost for doing business overseas. In India, foreign companies winning import orders over $62 billion must use domestic suppliers for at least 30% of the order. In the Middle East, the UAE requires that at least 50% of the contract’s value has to be reinvested in the local economy by the recipient of the contract. Many “offsets”, however, have not provided the purchasing country what they had wanted: when Saudi Arabia, in 1985, purchased the $3.8 billion US Peace Shield program, the “offset” was targeted to create 75,000 jobs, yet the four resulting joint venture companies, as of 2009, only had 3540 staff. Taiwan, South Korea, and India are trying to formalize their needs for “offsets”, while the UAE and Saudi Arabia are overhauling or reviewing their “offset” policies (Pfeiffer, 2010c).

IX. Conclusion

The global defense industrial base is facing a number of challenges in the orientation and strength of its interdependencies across countries. The US and European nations are combating fiscal and economic burdens which may increasingly put pressure on various segments of the budget, including defense, as more funding becomes needed for additional areas. The shift in defense priorities toward irregular warfare and away from conventional warfare, as well as potentially greater fiscal austerity will lead to the elimination of programs, such as the F-22. With stagnation in the labor markets, Congressional representatives may become more vocal about the cancellation of certain programs due to the impact on local labor markets and the powerful regional spillover effects of defense spending. Moreover, with the shift in defense priorities in the US, certain areas of the defense industrial base are likely to exhibit growth and other areas are likely to exhibit attenuation. These areas of growth, such as UAV's, can spur the development of other sub-sectors of the defense industrial base. As new firms have the opportunity to enter segments of growth, older defense contractors with substantive legacy overhead costs, such as pensions, will struggle to maintain their cost-based competitive advantage as they re-orient their business base.

The interdependencies across the global defense industrial base will be impacted by reductions in military spending, as well as exchange rate fluctuations, which can influence the profitability of global supply chain arrangements and the orientation of trade in military and commercial ships and aircraft. The growth in the defense budgets of other regions, such as India and the Middle East, and their significant demand for traditional military equipment for conventional warfare will result in an overseas re-orientation of conventional weaponry-focused aspects of the defense industrial base for US and European contractors, as demand in their domestic markets for these products lessens. Increased alliances and "offset" agreements between defense contractors in developed countries and in the

developing nations will foster the growth of their defense industrial bases, thus re-orienting the regional aspects of the global defense industrial base over time. In conclusion, the evolving fiscal, economic, and strategic landscape will hopefully contribute to the development of a more cost-effective and transparent global defense industrial base over time, as countries and companies re-orient and further develop their respective industrial bases and business bases

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